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"Pin-Shaped Connecting Element"

The subject matter of the present invention is a pin-shaped connecting element.

In the case of pin-shaped connecting elements, industrial standards differentiate among other things between parallel connecting pins and tapered connecting pins. These pins are mainly used to connect machines and equipment parts, with an interference fit being present between the pin and the hole.

The quality of the interference fit that can be achieved with such pin-shaped connecting elements is mainly dependent on the conformity between the surfaces of the pin and those of the hole that come in contact with each other. In order to ensure that surface contact is as large and as uniform as possible and thus that the desired interference dimension between the pin diameter and the hole diameter is achieved, the pins are cylindrically ground as precisely as possible within narrow tolerances, and the corresponding holes are reamed after being drilled. Despite these preventative measures, it is not possible to prevent a pin that has been driven into its hole to be in closer contact with the corresponding hole walls in some areas of the surface compared with the rest of the surface, while at the same time for there to be areas in which an average surface

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pressure is not achieved. Thus, it is not possible with conventional machining methods to impart a macrogeometrically and microgeometrically precise coinciding shape to the surfaces of the pin and the corresponding wall of the drilled hole in order to achieve uniform surface pressure in all locations and thus to achieve maximum strength values. In order to avoid expensive fitting modifications of the parallel pin, the use of parallel grooved pins is encountered in the prior art. The parallel grooved pins usually have three longitudinal grooves distributed about their circumference, whereby bulges are present on both sides of the grooves. When the pin is pressed into a cylindrical hole, the effect of the grooved pin is that the pin material deforms as a consequence of the elastic effect of the groove bulges and is displaced back into the walls of the drilled hole, so that the pin is clamped in the hole with a force fit. If the material of the grooved pin is harder than that of the workpiece or is as hard as that of the workpiece, small grooves are produced in the walls of the hole. One disadvantage with a compression interference connection utilizing parallel grooved pins is that, when the pin is pressed in, the workpieces can change position depending on the play between the pin and the hole diameter. If the workpieces must be precisely positioned relative to each other, it is necessary to use an ungrooved parallel pin as the connecting part.

The use of hammer-head bolts that have a multiple-pitch extremely steep thread instead of parallel grooved pins is also known. The resulting connection is comparable to that achieved with a knurled interference connection, in which the disadvantage referred to with regard to the parallel grooved pins occurs to an even greater extent—in other words, the workpieces are no longer aligned in a single axis after they have been joined together.

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The invention therefore relates to the object of creating a pin-like connecting element in which all of the pin and hole surfaces that contact each other have an optimal surface pressure that is as uniform as possible.

This object is accomplished by the invention in that the surface of the pin is provided with uniformly distributed groove-like recesses, and these recesses have an approximately semicircular cross section and are formed in the preferred embodiment by at least one spiral groove that extends over the entire length of the pin.

According to the invention, a connecting element is therefore proposed that differs from the conventional parallel and tapered pins in that its closed surface is interrupted by grooves or recesses that are prepared by means of material-removing or non-material-removing machining. In the preferred non-material-removing forming process, in particular a rolling in of the spiral groove is used.

If such a connecting element is hammered into the corresponding hole, then—as studies have shown—a stress state is established between the surface of the pin and the bore hole wall, and this stress condition is substantially more uniform than those observed in pins whose surfaces are not subdivided. Needless to say, this stress condition also depends on the fit between the pin and the corresponding hole. If the fit is tight, plastic deformations can occur on the surface of the pin, and these deformations lead to the formation of bulges that extend into the spiral groove. The formation of such bulges

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increases the strength with which a pin is seated in its hole.

If the proposed spiral groove is rolled into the surface of the pin, this can be done on bar stock using conventional methods and machines. The surface of the bar stock can be left unground, since the rolling operation results in adequate smoothing and since a corresponding strengthening of the bar stock can also be achieved. Rolling in the spiral groove is extremely economical, since the spiral groove results in a very large pitch angle, and a correspondingly large machine feed-forward can be used The rod stock is cut off to the pin length, once the spiral groove has been rolled in. Thus, the shaping of the edges between the groove and the surface is of particular importance. These edges must not be sharp, but rather they must be rounded, so that these edges do not produce any furrows in the hole wall.

One preferred embodiment of the invention is described in greater detail below using the attached drawing. The drawing shows:

Fig. 1—A parallel pin or a tapered pin provided with four spiral grooves.

Fig. 2—A cross section through the pin following line A-A in Fig. 1.

Fig. 3—Shows a schematic diagram of the stress state in the area of a land, seen in the direction in which the tapered pin is hammered in.

Fig. 4—The same stress state in the area of a land, seen transverse to the direction in which the pin is hammered in.

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The pin 1 shown in Figures 1 and 2 has a ground or unground surface that is divided by four rolled-in spiral grooves 2 that extend along the length of the pin. The pin is provided with a crowned face surface 3 on one end and a chamfered face surface 4 on the other end. The spiral grooves 2 are separated from each other by means of lands 5, which have a larger cross section relative to the more or less semicircular grooves 2. The edges, in other words the transitions between the grooves 2 and the lands 5, are rounded, in other words they have a convex shape.

The pin 1, which is hammered into a corresponding hole in the direction of the arrow 8, possesses in one section 6 the stress condition indicated in Figs. 3 and 4 relative to the corresponding hole wall. The surface 9 of this section 6 is assumed to be flat for the purpose of this highly enlarged representation in Fig. 4, even though it possesses a curvature determined by the diameter 16 of the given cross section. When the pin connection is in the resting position, a knife-edge load that acts in the direction of the arrow 7 is created, and this load generates the extended lines 13 used to visually represent the stresses. The dashed lines 14 show the condition that is present as plastic deformation occurs when the pin is hammered in. This plastic deformation is indicated by the cross-hatched zone 11. Such plastic deformation causes bulges 12 to form, and these bulges mold into the spiral grooves 2, as is shown especially clearly in Fig. 4. In this figure the cross section of the given land 5 is indicated with the number 10, and reference number 15 indicates the semicircular base of the adjoining spiral grooves 2. This stress state, which can be identified by means of optical stress testing, corresponding to lines 13 and

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14, results in a redistributed, closed surface and a substantially more uniform surface pressure relative to the surrounding walls of the hole, compared to what would be obtained with a tapered pin, and as a result the pinned connection achieves greater strength. Here, the cross-sectional shape of the spiral grooves only plays a lesser role, although a more or less semicircular shape is preferred for strength-related reasons.

– Continues with patent claims –

<u>What is claimed is</u>:

1. A connecting element in the form of a pin having a cylindrical or conical surface, wherein the pin surface is provided with uniformly distributed groove-like recesses.
2. The connecting element of Claim 1, wherein the recesses have a more or less semicircular cross-section.
3. A connecting element of Claim 1 or 2, wherein the resources are formed by at least one spiral groove that extends over the length of the pin.
4. The connecting element of Claim 3, wherein the spiral groove has a very large lead angle.
5. The connecting element of Claim 3 or 4, wherein the spiral groove is rolled into the surface of the pin.
6. The connecting element of one or more of Claims 1 to 5, wherein the pin surface is ground.
7. The connecting element of one or more of Claims 1 to 6, wherein the pin surface is provided with four rolled-in spiral grooves that extend along the entire length of the

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pin, that are spaced at the same distance from each other.

8. The connecting element of one or more of Claims 1 to 7, wherein at least one pin end is provided with a flat, crowned, or chamfered face surface.

9. The connecting element of one or more of Claims 1 to 8, wherein, when viewed in a cross section, the surface of the land is larger than the groove area.

10. The connecting element of one or more of Claims 1 to 9, wherein the transitions between the grooves and lands are rounded in a convex shape.

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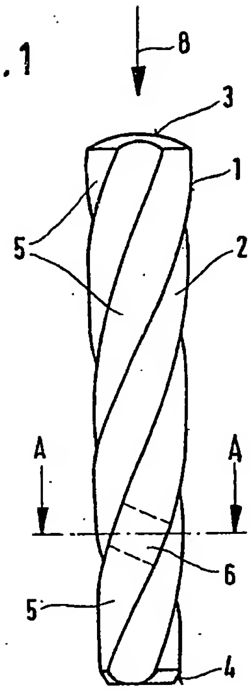
FIG. 1



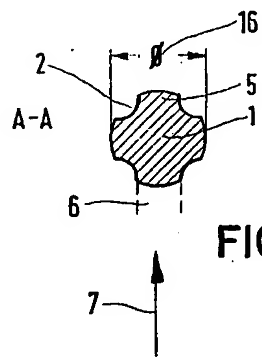


FIG. 2

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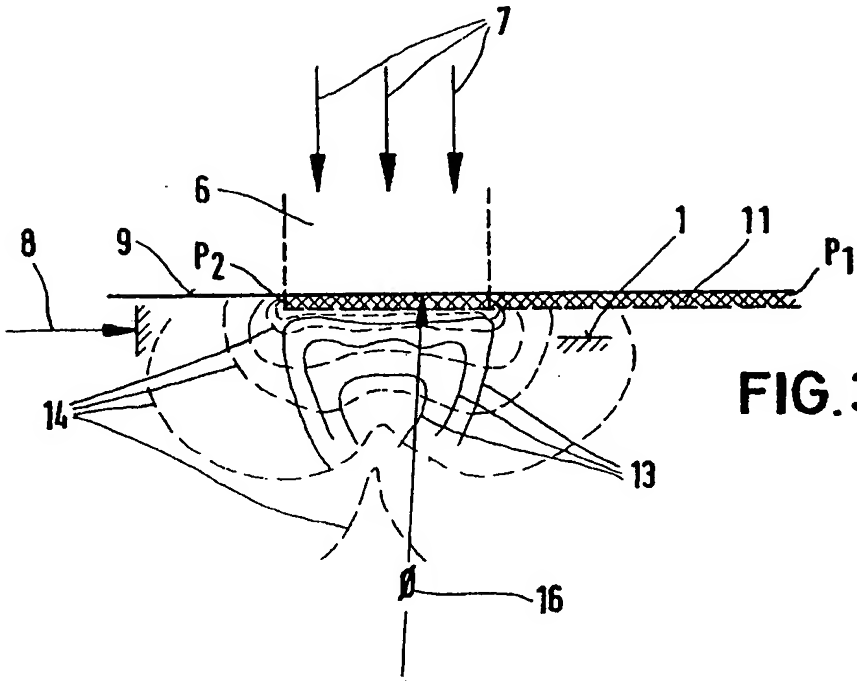

FIG.3

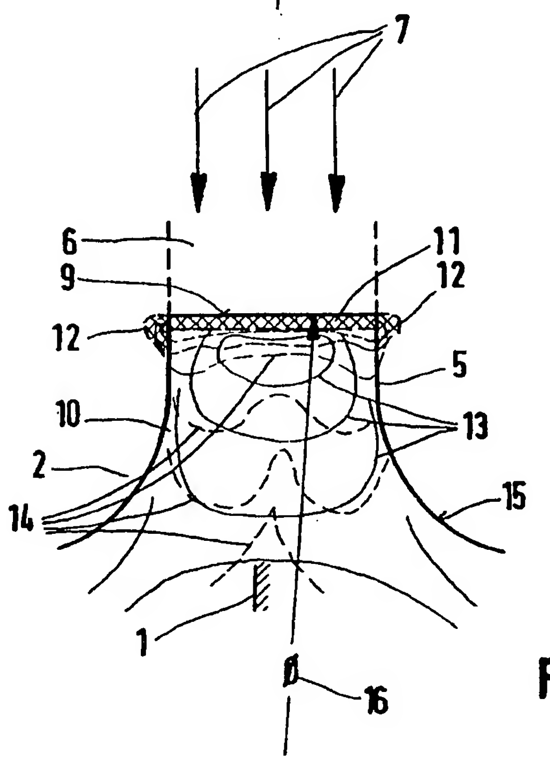

FIG.4